

# 1. Introduction and Background

Early in 1991, the state of California was facing a fifth year of drought. Water deliveries to agriculture were cut by 75 to 100 percent in some areas, and urban areas faced 15- to 45-percent reductions in water supplies. To help alleviate the impact of the drought, Governor Pete Wilson established the 1991 Drought Water Bank, which was to be managed by the California Department of Water Resources (DWR).

Because of the emergency nature of the Water Bank, DWR, which had sole responsibility for locating, negotiating, purchasing, and redistributing water, was able to move quickly with little constraint. DWR eventually bought over 821,000 acre-feet<sup>1</sup> for approximately \$100 million from farmers, landlords, and water agencies in 13 counties in central and northern California.<sup>2</sup> Most water was purchased for \$125 an acre-foot. Figure 1.1 shows the counties where the water was purchased. DWR then sold about 60 percent of the resulting net water purchases<sup>3</sup> at \$175 per acre-foot (plus transportation costs) to water districts in urban areas and to farmers raising permanent crops with "critical water needs." Urban agencies accounted for approximately 80 percent of the sales and were located in Southern California and in the San Francisco Bay area. The agricultural agencies were on the west side and southern end of the San Joaquin Valley.<sup>4</sup> Heavy rains in March 1991 and revisions in projected water use caused both urban and agricultural agencies to reduce or withdraw requests for Water Bank water. Consequently, the State Water Project, which is managed by DWR, bought the remaining 40 percent of unsold water as insurance against a possible sixth year of drought. That water was then delivered to project contractors (mainly agricultural water districts in the San Joaquin Valley and the Metropolitan Water District in Southern California) when 1992 became California's sixth year of drought.

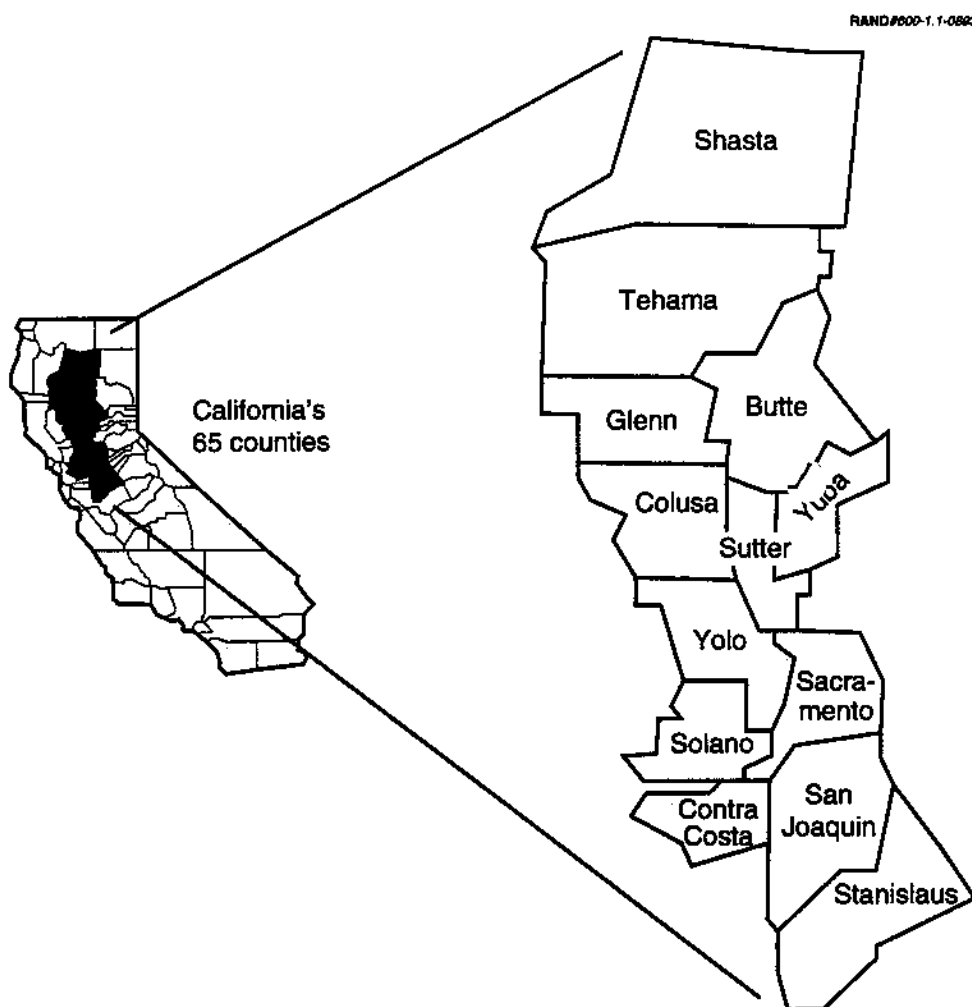
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<sup>1</sup>An acre-foot of water is the amount of water needed to cover 1 acre to a depth of 1 foot. One acre-foot is approximately 326,000 gallons. Also abbreviated as AF in tables.

<sup>2</sup>There is some debate over whether DWR paid for more water than it actually received. This issue, however, is beyond the scope of this study and does not affect the analysis of overall economic impacts done here. Also, very little water was bought in Stanislaus and Tehama counties (less than 1,500 acre-feet combined). In much of the analysis that follows, these counties will be dropped when evaluating the impact of the Bank on the local economy.

<sup>3</sup>Some of the purchased water was lost in transport through the Sacramento-San Joaquin Delta.

<sup>4</sup>The San Joaquin Valley runs from just south of Sacramento to the Tehachapi mountains.



**Figure 1.1—Counties in Selling Region**

As the Bank moved forward, significant concerns began to arise about the impact of DWR's water purchases on the economy and environment of local communities. Local businesses were concerned about a loss of business if farmers who sold water to the Bank bought less seed, chemicals, petroleum, and other supplies and employed fewer applicators, harvesters, haulers, processors, and other contractors. Labor organizations were concerned about job losses by farm workers. County representatives were concerned about the impact of reduced employment and business activity on county tax revenue and welfare expenses and about the impact of additional groundwater pumping on land subsidence and overdraft. Environmentalists were concerned about the loss of habitat, food, and nesting for migrating waterfowl and the fish losses in the

Sacramento–San Joaquin Delta<sup>5</sup> from aqueduct pumping and increasing salinity levels.

Late in 1991, DWR contracted with RAND to estimate the economic impact of the Bank on the agricultural communities where water was purchased. This report presents the findings of that study.

## Background on the Bank

DWR offered three types of contracts to farmers, landlords, and water agencies during the 1991 Bank: no-irrigation contracts, groundwater contracts, and stored-water contracts. The purchase price was set by a Water Purchase Committee of potential buyers. Under each of these contracts, the purchase price was almost always \$125 per acre-foot. We discuss each of these contracts in turn.

**No-Irrigation Contracts.**<sup>6</sup> The farmer agreed not to irrigate a specified number of acres from contract signing (between February and April 1991) to October 15, 1991. The surface water not diverted for irrigation was left in the stream or river. DWR made use of this water in two ways: (1) by directly pumping the water from the delta via the Harvey O. Banks Pumping Plant or (2) substituting this water as outflow to help meet delta water quality requirements in lieu of releasing water from upstream storage. To ensure that farmers reduced water use by the amount sold, the amount of water purchased per acre depended on the crop that would have been grown and the particular type of soil. DWR gave farmers a list of crops and proposed compensation from which the farmers could choose. The only constraint was that the farmer had to have a history of crop production to support the crops they promised not to irrigate—otherwise farmers could have promised not to grow a high water-using crop when they actually would have grown a low water-using crop.

Crops put in the Bank under no-irrigation contracts were of two types. First were those crops that had already been planted, either during the 1991 growing season or in previous years (alfalfa, for example, can stay in the ground for many years). Farmers agreed not to continue irrigating these crops, but they might well continue cultivating them and harvest a reduced yield. Second were crops that were not yet planted. Farmers may have already done preplanting field preparation and cultivation, but there would be no crop to harvest.

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<sup>5</sup>The delta lies between San Francisco and Sacramento.

<sup>6</sup>DWR refers to these as *fallowing contracts*.

**Groundwater Contracts.** DWR offered to buy some water that was pumped directly from the ground and sold to the Bank. In most cases, however, DWR offered to pay farmers or water agencies to pump groundwater in exchange for an equal amount of the seller's surface-water allocation. These contracts were thus actually groundwater-exchange contracts in which sellers were supposed to reduce surface-water use by the amount of groundwater pumped.

Groundwater-exchange contracts required DWR and United States Bureau of Reclamation staff to ensure that each well in the program was not drawing water that seeped from nearby rivers, and pumping from each well was metered.

In a few cases, DWR offered to buy surface water from water agencies with no restrictions on how the agency or farmers within the agency could respond to the cutback. The agency or farmers could either pump groundwater to replace the lost surface water (similar to groundwater-exchange contracts) or simply use less water either through fallowing (similar to no-irrigation contracts) or applying less water per acre. We refer to these contracts as *multiple response contracts*, because DWR did not know whether the farmers offset the surface-water reductions with groundwater pumping or not.

**Stored-Water Contracts.** DWR also offered to buy water stored in reservoirs. This water was in reservoirs that were operated according to a state permit or license, and the sale required approval of the State Water Resources Control Board for a change in the place and purpose of use.

### *The Decision to Sell*

A farmer, landlord, or water agency presumably decided to sell to the Bank if the expected net revenue was positive. In the case of no-irrigation contracts, farmers had to weigh expected reduction in crop revenue against the Bank payment plus the expected reduction in farm operating costs. In the case of groundwater contracts, if the seller expected to use groundwater, the pumping costs also had to be taken into consideration. Risk was presumably also taken into account. A farmer, for example, might have preferred the certainty of a Bank payment to the uncertainty of crop income that depends on many uncertain events, such as weather, plant diseases, and crop prices.

Even if selling water to the Bank looked profitable, a farmer might not have put his or her entire operation in the Bank. The Bank was temporary, so the farmer presumably would have expected to farm the following year. In that case, the farmers might have wanted to maintain the crop base needed to qualify for government programs or maintain a labor force that may have been well-trained and may have had considerable farm-specific knowledge.

### ***1991 Drought Water Bank Purchases***

As shown in Table 1.1, over half of the Bank's water came through no-irrigation contracts. Twenty-one crops were put in the Bank using this type of contract, although corn and wheat account for over 60 percent of the total acreage.

Table 1.2 contains a list of the crops put in the Bank categorized by whether they were planted and not irrigated or were not planted.

**Table 1.1**  
**Sources of Bank Purchases by Contract Type**

Contract Type	Acre-Feet (000s)	Percent of Total
No-irrigation	420	51
Groundwater	259	32
Stored water	142	17
<b>Total</b>	<b>821</b>	<b>100</b>

SOURCE: DWR (1992), p. 2.

**Table 1.2**  
**Summary of Crops Put in the Bank Through No-Irrigation Contracts**

Crop	Acres
Planted, not irrigated	
Wheat	43,584
Pasture	16,188
Alfalfa	10,219
Safflower	4,398
Barley	721
Seed grass	527
Grapes	254
Sudan grass	132
Dichondra	27
Not planted	
Corn	59,276
Sugar beets	9,951
Rice	8,180
Tomatoes	4,347
Dry beans	3,236
Sunflowers	2,769
Asparagus	1,277
Misc. truck	540
Milo	229
Melons	167
Turnips	35
<b>Total</b>	<b>166,093</b>

SOURCE: DWR (1992), p. 4.

Few land rental agreements in 1991 apparently contained clauses on whether the landlord or tenant had the right to sell water and how the proceeds would be shared. DWR made an effort to include both landlord and tenant in the contract, or to have an agreement between the two, but this was not always successful. Thus, there were some cases where a tenant sold water to the Bank and the landlord was completely unaware and some cases where the landlord sold water to the Bank, retained the payments, and the tenant was left with a reduced surface-water allocation. It is likely that clauses that address these issues will quickly find their way into future leasing agreements.

DWR purchased 259,000 acre-feet through groundwater contracts. Most of these contracts were with water agencies, although some were with individual farmers. In some cases, the agencies charged individual farmers a fee for their services and simplified the participation in the Bank for sellers and DWR. Thus, groups of sellers were bundled into single contracts.<sup>7</sup> Sometimes, however, it is not clear that the farmers in the districts, typically tenant farmers, were aware of the sale. Some farmers were told their surface water allocation was reduced, but they had no idea it was because of the Bank. As in the case of no-irrigation contracts, who had the right to sell water was unclear.

Based on our evaluation of the groundwater contracts, we estimate that approximately 19,000 acre-feet were either directly pumped from the ground or did not result in any surface-water reduction to farmers. In the latter case, the agency pumped groundwater into its surface-water distribution system to completely replace the sold surface water.<sup>8</sup> An additional 140,000 acre-feet were purchased through groundwater-exchange contracts, and 100,000 acre-feet were purchased through multiple-response contracts.

In many cases, DWR knew very little about the arrangements that underlay groundwater contracts. They often did not know which farmers and parcels of land were represented in the contract, and for multiple-response contracts, whether farmers pumped groundwater or not. From the point of view of DWR, these were black-box contracts, and only the water agency that negotiated the contract had detailed information.

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<sup>7</sup>Agency management fees varied from agency to agency. Some were a small percentage of Bank payments. Yuba County Water Agency, in contrast, charged \$25 per acre-foot.

<sup>8</sup>This did not preclude the water agency from reducing water deliveries due to the drought.

DWR purchased 142,000 acre-feet of stored water, most of it from the Yuba County Water Agency and the Oroville-Wyandotte Irrigation District in Yuba County.<sup>9,10</sup>

To put the amount of water purchased in perspective, DWR estimates that in 1990 approximately 2.9 million acres were irrigated in the 13 counties that sold water to the Bank.<sup>11</sup> DWR estimates that 2.15 acre-feet of water were used per acre and that agricultural usage was 6.2 million acre-feet in these 13 counties.<sup>12</sup>

### ***The 1992 Bank***

The 1992 water year was also a drought year. Even though the State Water Project purchased a large amount of water from the 1991 Bank, there were still substantial shortages in many parts of the state—particularly in agricultural areas where water cutbacks had been most severe. DWR created and ran a much smaller 1992 Bank, purchasing 193,000 acre-feet. DWR learned many lessons from the first Bank and applied them to the 1992 Bank. The most notable changes were its decisions to emphasize groundwater-exchange and stored-water contracts, to avoid no-irrigation contracts if possible, and to lower the price to \$50 per acre-foot. In our analysis of the 1991 Bank, we will occasionally make comparisons with and reference to the 1992 Bank.

## **Winners and Losers from Bank Transfers**

Since the sales of water to and purchases from the Drought Water Bank were voluntary, the sellers and buyers presumably benefited from Bank transfers. The sellers were farmers, landlords, and water agencies, although, as discussed above, uncertainty over who has the right to sell and over the distribution of the proceeds may result in little gain, or even losses, for some of these parties in certain circumstances. In urban areas purchasing the water, the benefits would accrue to the final purchasers of water and those they employ. For example, the increased water availability may have allowed planned landscaping projects to go ahead. This would have benefited both the owner of the facility and the landscaping industry. In agricultural areas purchasing water, the extra water

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<sup>9</sup>DWR also purchased several thousand acre-feet of stored water from the delta at \$35/acre-foot.

<sup>10</sup>For more detail on the 1991 Drought Water Bank, see DWR, 1992.

<sup>11</sup>Based on crop acreage data provided by DWR. DWR data are based on county agricultural commissioner reports.

<sup>12</sup>Based on the evapotranspiration of applied water (ETAW), which excludes the amount of crop water use and soil evaporation satisfied by rainfall. Figures provided in electronic communication from DWR (1993).

may have saved permanent crops like orchards and reduced farmer losses and layoffs of agricultural workers from what they would otherwise have been.

The potential losers from Bank sales are the businesses and individuals that supply farm inputs and handle or process farm outputs in the selling regions. Farmers that sold water to the Bank may reduce crop production. This will likely hurt the suppliers of farm inputs, such as farm workers and fertilizer and pesticide vendors, as well as the handlers and processors of farm output, such as haulers and canneries.<sup>13</sup>

Decreased farm activity may also adversely affect local governments and their taxpayers. For example, lower farm input purchases would lead to reduced tax revenues. Less economic activity might lead to increased welfare payments and other social service costs for displaced workers. In addition, less economic activity might lead to decreases in donations and increases in demands for nonprofit deliverers of social services.

On the other hand, the receipt of large Bank payments by sellers may have some wider benefits in the selling region. Farmers may increase investment in their farms. Demand for a wide range of goods and services in the local economy may increase. It is important to note, however, that while increased investment and consumption would benefit some in the local economy, they are not necessarily the same people hurt by the cutback in farm production.

### *Focus of This Study*

The focus of this study is to investigate and quantify the economic impacts on parties adversely impacted by the Bank. We examine what aspects of the Bank caused the most adverse impacts and, based on our findings, suggest modification in future Banks that would reduce these impacts. While this is a partial analysis of the Bank, we think it warranted by the concerns raised by many about this aspect of the Water Bank.

There are many other issues associated with the 1991 Drought Water Bank that are not examined here. Examples of these issues include the benefits of the Bank to the buying regions,<sup>14</sup> who has a right to sell water and how much they can

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<sup>13</sup>The dairy, cattle, and horse industries may also be hurt to the extent that the Bank caused lower production of the wheat, barley, corn, and alfalfa that are used for fodder. However, with the possible exception of alfalfa, we think it likely that these industries were able to find substitute sources and assume no such impacts.

<sup>14</sup>A RAND study cosponsored by DWR and the California Urban Water Agencies is currently under way to evaluate the benefits in the urban areas that purchased water. A report is scheduled to be published in early 1994.



sell; whether DWR should run future banks and how regulated they should be; and how best to protect the environment from adverse impacts and/or to enhance it during future banks.

## **Impact of the Bank on the Farm Economy**

The impact of the Bank on the local farm economy likely depended on the type of water purchase contract. Farmers who entered no-irrigation contracts likely reduced farm operating costs to some extent. Operating costs are crop cultivation costs that vary with the scale of production in the short run.<sup>15</sup> Operating costs include expenditures on seed, labor, fuel, pesticides, fertilizers, equipment rentals, contractors, haulers, and water. They do not include costs that do not vary with the scale of production in the short run. Examples of excluded costs are loan payments, land leases, property taxes, and insurance. Farmers with no-irrigation contracts may have more intensively cultivated land they did not put in the Bank. For example, instead of laying off labor, they may have shifted labor to non-Bank acres.

Because different crops require different levels and mixes of inputs, the impact of the Bank on operating costs likely depended on the type of crop put in the Bank. Wheat, for example, requires relatively few inputs to grow and harvest, while sugar beets or tomatoes require relatively large amounts of inputs.

Farmers might also have taken advantage of the money from the Bank, idle fields, and perhaps the additional time available to make investments in their farms. They might, for example, have shifted workers to maintaining or improving an irrigation system or to maintaining or fixing farm equipment and buildings. They may also have hired outside contractors to do the work. Examples include farms that laser-level<sup>16</sup> fields or drill groundwater wells.

Farmers with no-irrigation contracts likely produced and sold fewer farm products. This would affect the processors and handlers of farm products. These include refiners, canners, distributors, storers, and marketers. The impact on downstream processors and handlers would also likely vary with the type of crop put in the Bank. Some crops may require little downstream processing, while others require a great deal. Alfalfa, for example, may be used mainly as feed on other farms and thus may require little handling other than transportation. Sugar beets, on the other hand, are processed in large refineries.

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<sup>15</sup>In economic terminology, these correspond to the variable costs of production.

<sup>16</sup>By using laser beams to guide their equipment, farmers can precisely level their fields, and thus make more efficient use of applied water.

The amount of downstream processing may not be highly correlated to the price the farmer receives for the crop.

Farmers with groundwater-exchange contracts agreed to pump groundwater to replace the surface water sold to the Bank. Thus, there may have been little effect on the suppliers of inputs. However, if the groundwater was of inferior quality (salinity or temperature) or could not be applied at the optimal time, there may have been impacts on crop yields and on processors and handlers of farm products.<sup>17</sup>

Farmers with multiple-response contracts could pump groundwater to replace the surface water they sold to the Bank. Farmers presumably decided whether to pump groundwater depending on its availability and cost. For example, if groundwater cost more than the surface water they sold, they may have decided to pump less of it and either fallow the acreage or reduce the amount of water applied per acre. Consequently, their input purchases, aside from pumping costs, and crop sales may have changed. As will be discussed in Section 2, we found that not all farmers in agencies with multiple-response contracts had groundwater pumps. We would expect both the input purchases and crop production of these farmers to fall.

As mentioned above, some water bought through groundwater contracts had no impact on the water available to farmers. Because these purchases should have no impact on farm operations and thus on the suppliers of farm inputs and processors of farm output, we ignore them in evaluating the Bank's negative impacts.<sup>18</sup>

The regions that sold stored water had water in surplus to their needs. Therefore, DWR's purchases of stored water did not have any adverse economic impacts in the region. We also ignore these purchases in evaluating the Bank's negative impacts—although some have raised concerns about their environmental impacts. However, when evaluating the impact of the Bank on the overall economy in the selling region, we will include the \$17.7 million injected into the selling region by stored-water purchases.

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<sup>17</sup>Limited pump capacity may mean that it may take longer to irrigate a crop than if surface water had been available.

<sup>18</sup>If the groundwater that was substituted for the surface water was of lower quality, there may be some negative impacts on yield. Also, to the extent that such pumping causes groundwater levels to fall, these purchases may create some long-term negative economic impacts by causing increased pumping costs. Evaluating these costs is beyond the scope of this study.

## Recent Studies of the Bank's Economic Impacts

In the fall of 1991, DWR contracted with three consultants to do a brief critique of the Bank (Howitt, Moore, and Smith, 1992). Their analysis of changes in cropping patterns in the selling areas during the four years preceding the 1991 Bank suggests that most of the Bank-generated changes in specific crop acreage were well within the normal variations except for the reductions in wheat and alfalfa in Contra Costa and Sacramento counties and corn in all counties other than Stanislaus. Using economic models of farm production costs and economic multipliers, the authors made a first approximation of the change in county income due to the Bank. Estimated changes in personal income due to the Bank ranged from a 2.0 percent increase in Yuba County to a 0.3 percent decrease in San Joaquin County.

The authors concluded that "Even in counties where land fallowing was extensive, the effect of Bank operations on local economies was small compared to the overall county economy. For some individuals, however, Bank operations had significant adverse economic effects."<sup>19</sup>

A 1992 University of California (UC) study of gainers and losers in Solano and Yolo counties during the 1991 Bank used a survey of 188 farmers and a farm economic model to estimate the direct impacts of the Bank and a smaller Solano County bank on farm workers and farmer profits.<sup>20</sup> They also estimated the banks' impacts, including county income and jobs, using a county input/output model. They estimated that agriculturally related income fell 3.5 percent in Solano County and 5.0 in Yolo County because of the banks. Lastly, they surveyed 108 affiliated agricultural industries and asked for quantitative information on financial variables and perceptions of the impact of the Bank. Estimates of reductions in payroll were then compared with results from the economic model.

Most of the UC analysis of the impact of the Bank on farmer behavior and agriculturally related income in Yolo and Solano counties appears to be based, so far, on economic models of the farm and the county. The drawback of this approach is that these models may not correspond well to how the farmers who participated in the Bank actually changed their behavior. For example, the farmer may have harvested a reduced yield on land in the Bank that was planted and not irrigated. He or she may have shifted some of the labor and equipment

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<sup>19</sup>Howitt, Moore, and Smith (1992), p. 20.

<sup>20</sup>Coppock and Kreith (1993).

to land not in the Bank and thus increased output there. These types of models are not well suited to picking up these substitutions.

The UC study did use survey data on how the Bank affected agricultural business. However, there is no discussion on whether, or how, an attempt was made to isolate the impact of the Bank on local business from changes caused by other factors, such as the recession, the Christmas 1990 freeze, or drought-related water shortages other than the Bank. The UC report concluded that "Almost all farmers in Solano and Yolo Counties who sold water were financially better off as a result of the 1991 water transfers." They also concluded that "other farmers were not hurt "except for impacts on groundwater and some return flows. " Lastly, they concluded that "third-party effects were relatively low on a countywide basis, but were excessively concentrated in particular geographical areas." They go on to recommend moderate limits on future bank sales to reduce third-party impacts and caution against completely unregulated sales.

A 1993 report sponsored by The Bay Area Economic Forum and the Metropolitan Water District of Southern California on third-party impacts from water marketing estimated the employment impacts of a hypothetical 500,000 acre-foot transfer.<sup>21</sup> It compared the potential employment displacement of such a transfer to actual yearly variations in the farm labor market and the acreage that would be fallowed to acreage fallowed by the 1991 federal commodity programs. It also investigated ways to compensate displaced workers. The report concluded that third-party impacts are generally overstated in the public debate, that employment and production disruptions caused by marketing would be small, that the employment losses would be offset many times over by the creation of new jobs in surrounding urban areas, and that third-party impacts can be mitigated.

## Approach of This Study

Our research was based on the collection and analysis of survey data from the farmers and businesses involved in the Bank. Many of the projected economic impacts in the studies discussed above were based on economic models of farm behavior and the county economy. Our approach was to measure, as accurately as our budget allowed, the changes in farm operations caused by the Bank and their repercussions in the local economy. Our approach relaxed many assumptions made in other studies about what farmers would have done had there been no Bank. For example, we allowed for the possibility that farmers

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<sup>21</sup>Mitchell (1993).

may not have actually cultivated all the land they put in the Bank had there been no Bank. We also allowed for the possibility that farmers farmed the land they did not put in the Bank more intensively than they would have otherwise.

### *Outline of Report*

In the next section, we report our findings on the impact of the Bank on farm operations in 1991. We analyze how farmer purchases of farm inputs and crop sales were affected by the Bank. We also investigate how these impacts were distributed across the counties where DWR bought water and how they compare with overall county agricultural activity. In the last part of Section 2, we turn our attention from input suppliers and output processors to how the sellers themselves fared by participating in the Bank. Rather than examining the impact on input suppliers and output handlers and processors from the perspective of the farm, in Section 3, we examine it from the point of view of the impacted firms themselves. We then evaluate the consistency of the two sets of findings. In Section 3, we also investigate whether we can detect any impact on the overall economies of the counties where water was sold to the Bank. In Section 4, we move from a quantitative evaluation of the Bank to a more qualitative investigation. We first report findings on how agricultural businesses thought the Bank affected them and then report what farmers and businesses perceived to be the positive and negative impacts of the Bank on local communities and their suggestions on how future Banks should be managed differently. Each section concludes with a summary. In the final section, we discuss lessons learned and suggestions for future banks. The report concludes with three appendices that provide additional methodological detail.